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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/773,312	01/31/2001	Guarionex Morales	AMD18366US0 MCF/DBB	2747

23910 7590 12/20/2002

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EXAMINER

NGUYEN, HA T

ART UNIT	PAPER NUMBER
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2812

DATE MAILED: 12/20/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

09/773,312

Applicant(s)

MORALES ET AL.

Examiner

Ha T. Nguyen

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 15 October 2002.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1,3-23,25,29,30 and 48-50 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1,3-23,25,29,30 and 48-50 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.  
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).  
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_ 6) ☐ Other: \_\_\_\_\_

## DETAILED ACTION

### *Notice to applicant*

1. Applicants' Amendment and Response to the Office Action mailed 4-10-02 has been entered and made of record (Paper No. 10).

### *Response to Amendment*

2. In view of Applicants' cancellation of the claims, the rejection of claims 2 and 24 under 35 U.S.C. 102 or 103 has been rendered moot.

In view of Applicants' argument and the amendment to the claim, the rejection of claim 1 under 35 U.S.C. 102(b) as being anticipated by Wu et al. (US Patent 6013581) has been withdrawn.

Note that applicants did not rebut the examiner's Official Notice concerning conventional matter for example, many doped dielectric materials: BPSG, PSG, BSG are SOG materials, the examiner consider this feature to be admitted prior art.

Applicants' arguments with regard to the other rejections under 35 U.S.C. 102 or 103 have been fully considered, but they are not deemed to be persuasive for at least the following reasons.

Applicants argued that in all the rejection based on Kwon et al., U. S. Patent 6333260 (Hereinafter Kwon ), Liu et al., U S Patent 6080657 (hereinafter Liu) in view of Lu et al., U.S. Patent 6365517 (Hereinafter Lu) or their respective combination with other references does not teach a diffusion barrier of metal nitride or metal oxynitride. The examiner disagreed. Kwon discloses a layer 350 of Ti or TiN on the metal layer 310, TiN has characteristics of both a diffusion barrier and an ARC, in Kwon a layer 360 is also formed to protect the metal layer from diffusion of dopant from the doped-dielectric 400 or 405. In the rejection, the examiner considers layer 350, a metal nitride to be equivalent to the claimed diffusion barrier. Nothing in the claim preclude the existence of another diffusion barrier, protection layer beside the indicated diffusion barrier layer. Therefore, Kwon does teach a metal nitride, TiN diffusion barrier as claimed. In the same manner, layer 32 or TiN on an Al layer 30 or layer TiN 26 over a metal layer 24 are equivalent to the claimed barrier layer, the claims do not preclude the existence of another diffusion barrier layer, the claims do not require the diffusion barrier to protect the metal layer

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from all directions, therefore, even though layers 32 or 26 do not protect the underlying metal layer against diffusion from all direction they still meet the requirement of the claims. Therefore, Liu in combination with others references do teach all the limitations of the correspondingly rejected claims.

Applicants are referred to the new ground of rejection given below.

***Claim Rejections - 35 USC § 102***

2a. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless --

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371<sup>o</sup> of this title before the invention thereof by the applicant for patent.

3. Claim 48 is rejected under 35 U.S.C. 102(b) as being anticipated by Akram (U. S. Patent 5661334).

Referring to Figs. 1-5 and related text, Akram discloses a method of reducing diffusion of dopant ions from a doped dielectric layer into a metal layer, comprising the steps of: depositing on a metal layer 41, a diffusion barrier 11A, said diffusion barrier being comprised of a layer of aluminum nitride (see col. 3, lines 25-35 and col. 4, lines 32-42) and then depositing a layer of doped dielectric material 18A on said diffusion barrier (see col. 4, lines 32-42).

4. Claims 1, 20, and 21 are rejected under 35 U.S.C. 102(e) as being anticipated by Kwon et al., U. S. Patent 6333260 (Hereinafter Kwon ).

[Claims 1 and 21] Referring to Figs. 3-9 and related text, Kwon discloses a method of fabricating a semiconductor device, comprising the steps of: depositing on a metal layer 310 , a layer 350 which can be of Ti or TiN having diffusion barrier characteristics (see col. 5, lines 56-60), and then depositing a layer of doped dielectric material 400 or 405 on said diffusion barrier.

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[Claim 20] wherein said doped dielectric layer is selected from the group consisting of fluorine doped silicate glass (FSG or SiOF), phosphorous doped silicate glass (PSG), boron doped silicate glass (BSG), and boron phosphorous doped silicate glass (BPSG) (see col.8 , lines 9-21).

***Claim Rejections - 35 USC § 103***

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103<sup>©</sup> and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

6. Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kwon.

Kwon discloses substantially the limitations of claim 19, as shown above. It also discloses that the step of depositing a layer of doped dielectric material is carried out at a deposition temperature in the range of about 350 to 400C (See col. 8, lines 9-21 ).

But it does not disclose expressly the exact claimed range .

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a *prima facie* case of obviousness exists (See MPEP 2144.05).

Therefore, it would have been obvious to use Kwon's teaching to obtain the invention as specified in claim 19.

7. Claims 1, 3-13, 16-18, 20-23, 25, 49, and 50 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu in view of Lu et al., U.S. Patent 6365517 (Hereinafter Lu).

[Claims 1, 20, and 22] Referring to Figs. 3-6 and related text, Liu discloses a method of fabricating a semiconductor device, comprising the steps of : depositing on a metal layer 24, a nitrogen rich metal nitride layer 26; and depositing a layer of SOG material on said nitrogen rich metal nitride layer (see col. 3, lines 23-28);

[Claim 3] wherein said diffusion barrier is a layer of metal oxynitride (see col. 3, lines 29-42);

[Claims 4 and 5] wherein said layer of metal nitride has a thickness in the range of about 10 to about 1000 angstroms or in the range of about 50 to about 350 angstroms (see col. 3, lines 23-28);

[Claims 21, 49, and 50 ] wherein said metal nitride layer comprises a metal selected from the group consisting of aluminum, tantalum and titanium (see col. 3, lines 23-28).

But it does not disclose expressly the dielectric is a doped dielectric, a barrier layer thickness of 100 angstroms, and the details about the plasma.

However, the missing limitations are well known in the art because Lu discloses [Claim 6] wherein said layer of metal nitride has a thickness of about 100 angstroms (see col. 3, lines 14-16); [Claim 7] wherein said metal nitride is formed using a nitrogen rich radiofrequency (rf) plasma; [Claims 8-10] wherein the radiofrequency plasma is formed using hydrogen and nitrogen gases having a ratio in the range of about 0.1:1 to about 4:1, or 0.5:1 to about 2:1, or about 3:2 ; [Claims 11-13 ] wherein the rf plasma power is in the range of about 100 Watts to about 1000 Watts or about 400 Watts to about 800Watts, or about 750 Watts per 8 inch diameter wafer; [Claims 16-18 ] wherein the pressure in the plasma chamber is in the range of about 100mTorr to about 50 Torr, or about 1 Torr to about 10 Torr, or about 4 Torr (see col. 2, lines 57-col. 3, lines 16). The combined teaching of Liu and Lu does not disclose the exact claimed rf power or chamber pressure. However any variation in rf power or chamber pressure in the present claims is obvious in light of the cited art, because the changes in rf power or chamber pressure produce no unexpected function. The routine varying of parameters to produce expected changes are within the ability of one of ordinary skill in the art. Patentability over the prior art will only occur if the parameter variation produces an unexpected result. In re Aller, Lacey and

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Hall, 105 U.S.P.Q. 233, 235. In re Reese 129 U.S.P.Q. 402, 406. Besides, the examiner takes Official Notice that it is well known in the art that many doped dielectric materials, BPSG, PSG, BSG, FSG are SOG materials.

[Claims 23 and 25] The arguments used for the rejection of claims 1, 8-10, 21, and 22 also apply. Liu also discloses the steps of: providing a substrate 10; depositing over said substrate, a metal layer 24 from the group consisting of aluminum, titanium, tantalum and aluminum/tantalum. Lu also discloses a deposition temperature in the range of about 200C to about 450C (see par. bridging col. 2 and col. 3 ).

A person of ordinary skill is motivated to modify Liu with Lu to obtain lower cost and better quality TiN layer (see Lu, Summary of the Invention).

Therefore, it would have been obvious to combine Liu with Lu to obtain the invention as specified in claims 1, 3-13, 16-18, 20-23, 25, 49, and 50.

8. Claims 14 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu in view of Lu, as applied to claims 1, 3-13, 16-18, 20-23, 25, 49, and 50 above, and further in view of Inoue, US Patent 4976839.

The combined teaching of Liu and Lu discloses substantially the limitations of claims 14 and 15.

But it does not disclose expressly the presence of a noble gas selected from the group consisting of helium, neon, argon, krypton and xenon in the plasma.

However, the missing limitations are well known in the art because Inoue discloses the use of Argon in the reactant gases forming TiN (See col. 6, lines 32-49).

A person of ordinary skill is motivated to modify Liu and Lu with Inoue to obtain smooth and better controlled fabrication process of the TiN.

Therefore, it would have been obvious to combine Liu and Lu with Inoue to obtain the invention as specified in claims 14 and 15 .

9. Claims 29 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kwon in view of Applicants' admitted prior art (hereinafter APA).

Kwon discloses substantially the limitations of claims 29 and 30, as shown above.

But it does not disclose expressly that TiN barrier layer is formed using electromagnetic radiation or nitrogen ion implantation .

However, the missing limitations are well known in the art because APA discloses these features (see par. 0078).

It is within the level of skill of a person of ordinary skill in the art to use a conventional method to perform the same.

Therefore, it would have been obvious to combine Kwon with APA to obtain the invention as specified in claims 29 and 30.

10. Claims 49 and 50 are rejected under 35 U.S.C. 103(a) as being unpatentable over Akram in view of Wu et al. (U.S. Patent 6013581, hereinafter "Wu").

Referring to Figs.1-5 and related text, Akram discloses substantially the limitations of claims 49 and 50, as shown above.

But it does not disclose expressly that the barrier layer is of TiN or TaN .

However, the missing limitations are well known in the art because Wu discloses TiN and TaN are conventional diffusion barrier material (See col. 3, lines 51-65) .

A person of ordinary skill is motivated to modify Akram with Wu to obtain good diffusion barrier effect while lowering conductor resistivity.

Therefore, it would have been obvious to combine Akram with Wu to obtain the invention as specified in claims 49 and 50 .

### *Conclusion*

11. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for response to this final action is set to expire THREE MONTHS from the date of this action. In the event a first response is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37

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CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event will the statutory period for response expire later than SIX MONTHS from the date of this final action.

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ha Nguyen whose telephone number is (703)308-2706 . The examiner can normally be reached on Monday-Friday from 8:30AM to 6:00PM, except the first Friday of each bi-week.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Niebling, can be reached on (703) 308-3325. The fax phone number for this Group is (703) 308-7722.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956.



Ha Nguyen  
Primary Examiner  
12 - 17- 02